

1 22. The apparatus of claim 18, wherein said first photodetector is a PIN
2 photodiode or an avalanche photodiode.

1 23. The apparatus of claim 18, wherein said optical train includes a dispersive
2 element.

1 24. The apparatus of claim 18, wherein at least one of said dynamically
2 configurable elements is a rooftop prism whose position can be changed to define said first and
3 second states.

1 25. The apparatus of claim 18, wherein each of said dynamically configurable
2 elements includes a mirror whose orientation can be changed to define said first and second
3 states.

1 26. The apparatus of claim 18, wherein said second electrical circuit connected to
2 said second photodetector computes the total optical power incident on said photodetector and
3 sets a threshold for triggering a fault condition if said optical power falls below said threshold.

1 27. The apparatus of claim 20, in a system that further includes:
2 a coupler that directs a fraction of light traveling on a fiber to be monitored to said
3 optical train; and
4 a management processor that receives information based on said signal
5 representing a quality characteristic.

REMARKS

Status of Application

Claims 1-27 are pending. Claims 6-13, 15-23, and 25-27 have been rejected; and claims 14 and 24 have been objected to. Applicants note that the summary sheet of the Office Action lists claims 1-5 as rejected, but that the body of the Office Action states that they have been allowed. Applicants note with appreciation the allowance of claims 1-5. Applicants have amended the rejected independent claims in a manner that is believed to distinguish over the prior art.

Overview of Invention

The present invention provides wavelength monitoring techniques that allow one or more quality characteristics (e.g., signal-to-noise ratio, bit error rate, optical power level, optical wavelength center frequency) of each of a large number of wavelengths to be monitored without having to provide a separate detector and high-speed circuitry for each wavelength. This is accomplished by using a common photodetector and wavelength-monitoring circuit, and controlling a configurable wavelength-routing mechanism to direct different wavelengths to the detector at respective different times. This can be done in round-robin fashion for some or all of the bands, but there is no particular required sequence of monitoring the different bands. Indeed, the monitoring of bands can be done in an ad hoc manner in response to external requirements. In specific embodiments, a separate detector and power monitor is provided to monitor the optical power for selected ones or all of the bands simultaneously.

Prior Art Rejection

The prior art rejection is on the basis of U.S. Patent No. 5,745,271 to Ford et al. ("Ford"), either alone or in combination with one or more of U.S. Patent No. 6,278,535 to Shanton, III, U.S. Patent No. 6,204,946 to Aksyuk et al, and U.S. Patent No. 6,240,109 to Sheih. These references disclose various techniques deployed in wavelength division multiplexing (WDM) systems.

Ford discloses an attenuator that operates on a wavelength-by-wavelength basis. Ford's device includes, among other things, separate detectors and circuits for each wavelength, so that a given wavelength's optical power can be monitored and selectively attenuated. While the Ford system requires a separate detector and circuit for it to operate as intended, this is fundamentally different from the present invention, which avoids the need for a separate detector and circuit for each wavelength to be monitored.

The other cited references disclose various WDM techniques including wavelength monitoring, but none, alone or in combination with Ford, disclose or suggest the invention. For example, Shanton describes monitoring SONET frames for a single wavelength in a receiver module where there is one module per wavelength.

Applicants have amended independent claims 6 and 18 to recite, in one way or another, the aspect of the invention where a first wavelength band is directed to the photodetector

during a first time interval to provide a signal representing the quality characteristic for the first band, and a second wavelength band is directed to the photodetector during a second time interval to provide a signal representing the quality characteristic for the second band. More particularly, the control circuit recited in claim 6 has been amended as follows:

a control circuit coupled to said routing mechanism to cause [different] only a first selected spectral band to be directed [bands] to said photodetector during a first time interval and to cause only a second selected spectral band to be directed to said photodetector during a second time interval, whereby said electrical circuit provides, during said first and second intervals, respective first and second signals representing the quality characteristic for the first and second [different] selected spectral bands.

Claim 18 recites separate detectors with respective circuits for monitoring a wavelength quality and optical power, and the control circuit recited in claim 18 has been amended as follows:

a control circuit coupled to said routing elements operating
(a) to cause, during a first time interval, a first [different] selected one [ones] of said routing elements corresponding to a first selected spectral band to assume said first state while causing the [remaining] routing elements other than said first routing element to assume said second state; and
(b) to cause, during a second time interval, a second selected one of said routing elements corresponding to a second selected spectral band to assume said first state while causing the routing elements other than said second routing element to assume said second state;
whereby
said first electrical circuit provides, during said first and second intervals, respective first and second quality characteristic signals representing the quality characteristic for said first and second selected spectral bands, and
said second electrical circuit provides, during said first interval, a first optical power signal representing the optical power of the spectral bands other than said first selected spectral band, and during the second interval, a second optical power signal representing the optical power for the spectral bands other than said second selected spectral bands.

As discussed above, the prior art does not disclose or suggest the invention set forth in claims 6 or 18, as amended. Claims 7-17 and claims 19-27 depend from claims 6 and 18, which are believed allowable, and are therefore allowable. Claims 14 and 24 were also noted to recite allowable subject matter. Therefore, withdrawal of the rejection of 6-13, 15-23, and 25-27 is respectfully requested. This amendment does not add new matter.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1 6. (Amended) Apparatus for monitoring input light having a plurality of spectral
2 bands, the apparatus comprising:

3 an optical train that intercepts the input light and provides optical paths for
4 routing the spectral bands;

5 a photodetector;

6 a routing mechanism that operates to direct selected spectral bands to said
7 photodetector;

8 an electrical circuit coupled to said photodetector to provide a signal representing
9 a quality characteristic of a modulated or unmodulated pattern of light impinging on said
10 photodetector; and

11 a control circuit coupled to said routing mechanism to cause **[different]** only a
12 first selected spectral band to be directed [bands] to said photodetector during a first time
13 interval and to cause only a second selected spectral band to be directed to said photodetector
14 during a second time interval, whereby said electrical circuit provides, during said first and
15 second intervals, respective first and second signals representing the quality characteristic for the
16 first and second [different] selected spectral bands.

1 18. (Amended) Apparatus for monitoring at least one characteristic of input light
2 having a plurality of spectral bands, the apparatus comprising:

3 an optical train that intercepts the input light and provides optical paths for
4 routing the spectral bands;

5 first and second photodetectors;

6 a plurality of dynamically configurable routing elements corresponding to the
7 plurality of spectral bands, each routing element having first and second states, said first state
8 causing that routing element to direct its respective spectral band to said first photodetector, said
9 second state causing that routing element to direct its respective spectral band to said second
10 photodetector;

11 a first electrical circuit coupled to said first photodetector to provide a signal
12 representing a quality characteristic of a modulated or unmodulated pattern of light impinging on
13 said first photodetector;

14 a second electrical circuit coupled to said second photodetector to provide a signal
15 representing optical power of light impinging on said second photodetector; and

16 a control circuit coupled to said routing elements operating

17 (a) to cause, during a first time interval, a first [different] selected one
18 [ones] of said routing elements corresponding to a first selected spectral band to assume
19 said first state while causing the [remaining] routing elements other than said first
20 routing element to assume said second state; and

21 (b) to cause, during a second time interval, a second selected one of said
22 routing elements corresponding to a second selected spectral band to assume said first
23 state while causing the routing elements other than said second routing element to assume
24 said second state;

25 whereby

26 said first electrical circuit provides, during said first and second intervals,
27 respective first and second quality characteristic signals representing the quality
28 characteristic for said first and second selected spectral bands, and

29 said second electrical circuit provides, during said first interval, a first
30 optical power signal representing the optical power of the spectral bands other than said
31 first selected spectral band, and during the second interval, a second optical power signal
32 representing the optical power for the spectral bands other than said second selected
33 spectral bands.